Review
Patellofemoral Pain Syndrome:
Diagnosis and Management
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Patellofemoral disorders are a common orthopedic problem and can pose difficulty with regard to diagnosis and treatment. Anterior knee pain may be idiopathic or the result of localized articular and retinacular lesions, abnormal patellar alignment, or trauma. Therefore, to approach the problem of anterior knee pain more systematically, it is important to have a precise diagnosis.

The pathophysiology of patellofemoral pain is poorly understood. Articular cartilage is not innervated; however, lesions of the cartilage can irritate the synovium, which is a primary source of pain in the patellofemoral joint. Other important sources of patellofemoral pain include stretching of the synovium and abnormalities of such periarticular structures as the capsule, ligaments, retinaculum, bursae, and medial plica. In knees with morphologic changes of chondromalacia patellae, biomechanical failure of the articular cartilage may alter the load transfer to the subchondral patellar bone. Dynamic osseous remodeling of trabecular bone also may occur because of overload repetitive stresses.

Thickening of trabecular bone can close off venous drainage and increase intrasosseous venous pressure in patients with anterior knee pain or patellofemoral arthrosis. However, most young people with chondromalacia of the patella also have malalignment of the extensor mechanism, which, rather than the articular changes per se, is responsible for the pain.

EVALUATION OF ANTERIOR KNEE PAIN
Clinical Assessment.
The medical history, clinical examination, and imaging assessment all are important in making an accurate diagnosis. The type of pain and its location and onset, the mechanism of injury, and the factors that aggravate or relieve a patient's complaints are important in the differential diagnosis.

In the clinical assessment, the problem often is not solved by directing attention solely to the knee. Patients should be observed while they are in the standing and supine positions. Lower leg alignment (femoral anteverision, knee alignment, external tibial torsion, and foot pronation) should be noted; for example, excessive hip anteverision, excessive foot valgus, or pronation can cause or aggravate patellar maltracking. Prolonged or excessive foot pronation results in excessive internal rotation of the tibia, which concentrates stress on the periarticular soft tissues around the knee and produces peripatellar or anterior knee pain.

Patellofemoral crepitus, tenderness of the medial or lateral patellar facets, and pain with isometric contraction of the quadriceps under resistance at 0° and 20° may suggest chondromalacia of the patella. The results of an "prehension test" performed with the relaxed knee at 20° to 30° of flexion may be positive in patients with recurrent subluxation or dislocation of the patella. The quadriceps (Q) angle is measured. At 30° of flexion, the Q angle is normally less than 10° in males and less than 15° in females, and at 90° of flexion, it is less than 8°. Generally,

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EDUCATIONAL OBJECTIVES
1. Analyze the pathophysiology of patellofemoral pain syndrome and clearly explain its etiology.
2. Outline the necessary steps for diagnosis of patellofemoral pain syndrome.
3. Describe the available treatment options and their indications.
a Q angle greater than 20° is considered abnormal and is associated with patellofemoral lesions. Factors that can increase this angle include increased femoral anteversion, genu valgum, external tibial torsion, a laterally positioned tibial tuberosity, and a tight lateral retinaculum. Any of these factors can contribute to recurrent dislocation of the patella. Active and passive tracking of the patella and tightness or laxity of the lateral and medial restraints of the patella should be evaluated. The passive patellar tilt test evaluates the tension of the lateral restraint. In one study, the normal range was 0° to 20°, and an excessively tight lateral restraint was correlated with a successful outcome for patients undergoing lateral retinaculum release.

Imaging of the Patellofemoral Joint.

Plain Radiographs. Accessory ossification centers, osteochondral fractures, and valgus/varus can be assessed on anteroposterior radiographs of the patellofemoral joint, and patella posture in relationship to joint line can be evaluated on lateral radiographs (Fig 1). A ratio of patella length (LP) to patellar tendon length (LT) less than 0.8 suggests patella alta, whereas a ratio greater than 1.2 suggests patella infra.

The lateral patellofemoral angle, patella-lateral condyle index, lateral patella displacement, and lateral patellar tilt can be measured on infrapatellar views (Fig 2).

Two angles are described in the Merchant infrapatellar view: the congruence angle (average, −8° ± 6°) and the sulcus angle (average, 137° ± 6°) (Fig 2). In a study that compared 100 patients who had signs and symptoms suggestive of patellar malalignment with 100 patients who did not have a clinical patellofemoral disorder, the patellar tilt angle measured from the Merchant view with the knee at 30° of flexion was almost as specific as the congruence angle (92% vs 99%) and was more sensitive (85% vs 25%) and more accurate (29% vs 62%). In the same study, the mean patellar tilt angle in the group with patellofemoral malalignment was 12° ± 6° and in the control group, 2° ± 2° (P < .001). However, the authors of the study emphasized that measurements of the patellar tilt or patellar lateralization on the Merchant view may be inaccurate and misleading, because the Merchant view cannot be obtained if the knee is at less than 30° of flexion, and a large proportion of malaligned patellae is corrected in this degree of flexion. These authors emphasized the need for computed tomography (CT) and magnetic resonance imaging (MRI) in critically investigating patellar maltracking.

Cross-Section Imaging Modalities.

CT is effective for evaluating intraosseous lesions of the knee and patellofemoral relationships. It is also useful in planning selective surgical realignment according to different malalignment patterns: femoral anteversion, knee rotation, external tibial rotation, distance between anterior tibial tuberosity and trochlear groove, congruence angle and patellar subluxation, and patellar inclination angle. Standards have been defined for evaluating the patellofemoral joint with CT. CT is precise, reproducible, and avoids problems with overlapping images and variations of reference points, but it is expensive. CT is also valuable for the diagnosis of recurrent patellar subluxation in adolescents. In a study of 40 consecutive adolescents with the clinical diagnosis of recurrent patellar subluxation, CT revealed abnormal patellar centralization in 79%.

MRI provides information similar to that of CT, but it also can be used to assess the articular cartilage, quadriceps muscle, and medial and lateral patella retinaculum. MRI is difficult to perform if the knee is flexed more than 30°. The most reliable indicators of chondromalacia shown by MRI are focal contour irregularities and thinning of the hyaline cartilage associated with high signal intensity changes in T2-weighted images. Generally, Stage III and Stage IV chondromalacia can be evaluated reliably (with an accuracy of 89%) with MRI by using a combina-
tion of proton density and T2-weighted images. Lesions of the patellofemoral articular cartilage have been classified into four grades on the basis of MRI findings, with special attention to the surface and thickness of the cartilage. The MRI grades were compared with the grades of arthroscopy, and the following results were obtained: MRI grade 0—normal cartilage, sensitivity of 99.9% and specificity of 74.2%; MRI grade 1—thickening of the cartilage, sensitivity of 50% and specificity of 89.1%; MRI grade 2—surface irregularity over the cartilage, sensitivity of 85% and specificity of 94.7%; and MRI grade 3—loss of cartilage, sensitivity of 100%, and specificity of 100%. Dynamic Patellar Motion Imaging Studies. Less commonly, cine CT and kinematic MRI have been used to assess patellofemoral tracking and alignment. Bone Scintigraphy. The primary indication for the use of bone scanning is prolonged symptoms of anterior knee pain and uncertain diagnosis. Increased uptake at both the patella and distal femur has been thought to indicate a poor prognosis. A highly significant correlation has been reported between increased radioisotope uptake and established chondromalacia, with bone scanning having a positive predictive value of 72%. Arthroscopy. The primary role of arthroscopy is in the investigation of the extent of patellar articular lesions; its secondary role is in the confirmation of clinical and radiographic alignment. Arthroscopic assessment of patellar tracking is most effective without the use of a tourniquet and with the use of local anesthesia. The tracking of the patella and the dynamics of the patella and the patellofemoral joint can be viewed better with a superior portal. With the knee at 30° to 40° of flexion, persistent lateral tilt or overhang of the lateral facet over the edge of the lateral femoral condyle suggests a lateral tracking phenomenon.

Etiology of Anterior Knee Pain

Anterior knee pain may be idiopathic or it may be caused by malalignment or trauma. The most common clinical presentations are chondromalacia patellae, patellofemoral arthrosis, and instability syndromes.

Malalignment of the Extensor Mechanism.

Malalignment of the extensor mechanism is believed to be a frequent cause of patellofemoral pain and chondromalacic changes in the patellofemoral joint. The main patterns of malalignment include patellar subluxation and patellar tilt. Patellar subluxation can lead to increased risk of dislocation, instability of the extensor mechanism, apprehension, patellar hypermobility, and risk of articular or retinacular damage. Patellar lateral tilt differs from subluxation and is characterized by an increased lateral facet loading and adaptive shortening of the lateral retinaculum, with an increased risk of patellar arthrosis. The abnormal patellar tilt responds favorably to lateral retinaculum release. A high-riding patella predisposes to malalignment because the patella is late in engaging the stabilizing trochlea during knee flexion.

Malalignment caused by bony abnormalities, such as excessive femoral anteversion, excessive external tibial torsion, or severe genu valgum, may require surgical correction with osteotomy.

Trauma.

A correlation has been shown between trauma to the patellofemoral joint and histologic and MRI changes. Transarticular loading creates widespread damage of the cartilage and subchondral bone. Although the subchondral bone heals, cartilage clefs persist. Many patients with anterior knee pain have a history of direct trauma to the patellofemoral joint.

Acute Traumatic Dislocations of the Patella.

Acute traumatic dislocations of the patella are lateral and usually occur during the second decade of life. Predisposing factors for these disloca-

tions include patella alta, hypermobile patella, generalized ligamentous laxity, increased Q angle, increased femoral anteversion associated with relative external tibial rotation, atrophy of the vastus medialis obliquus, contracted iliotibial band, valgus deformity of the knee, deficient lateral femoral condyle, shape of the patella, genu recurvatum, lateral insertion of the patellar tendon, and hypertrophy of the vastus lateralis. The injury produces tearing of the medialis retinaculum and the vastus medialis obliquus. Associated osteochondral fractures of the lateral femoral condyle of the patella itself (usually involving the inferior portion of the medialis facet) may be present and may be the result of the dislocation or reduction. Fractures of the lateral patellar facet are rare, and few of them require surgical treatment. In the absence of predisposing factors or associated osteochondral fractures, immobilization for 2 to 6 weeks is usually effective for most patellar dislocations. Redislocation rates of 15% to 45% have been reported. Indications for operative treatment include a large rupture of the vastus medialis obliquus, a large osteochondral fracture, or the presence of predisposing factors. Although surgical repair reduces or eliminates the recurrence rate, up to 70% of the patients may still have residual pain or a sensation of instability.

Idiopathic Anterior Knee Pain.

Occasionally, no cause can be found for anterior knee pain. However, before the diagnosis of idiopathic anterior knee pain is made, specific pathologic causes must be excluded, including inflammation of the bursa, infrapatellar fat pad, or synovial membrane or impingement of the synovial membrane or synovial plicae. Reflex sympathetic dystrophy and articular and meniscal lesions must also be excluded.

Treatment of Patellofemoral Disorders

Fulkerson and Schutzer divided patients with patellofemoral pain into four categories on the basis of the pres-
TABLE

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<thead>
<tr>
<th>Classification</th>
<th>Definition</th>
<th>Treatment</th>
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<tr>
<td>I</td>
<td>Patellar subluxation with no articular lesion</td>
<td>LRR, VMO advancement</td>
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<tr>
<td>A</td>
<td>Patellar subluxation with grade I, II chondromalacia</td>
<td>LRR, VMO advancement</td>
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<tr>
<td>B</td>
<td>Patellar subluxation with grade III, IV arthrosis</td>
<td>LRR and possible anteromedial tibial tubercle transfer (Fulkerson)</td>
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<td>C</td>
<td>Patellar subluxation with a history of dislocation and minimal or no chondromalacia</td>
<td>In cases of acute dislocation, selective arthroscopy and reconstruction of osteochondral damage, consider LRR, delay reconstruction</td>
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<tr>
<td>D</td>
<td>Patellar subluxation with history of dislocation and grade III, IV arthrosis</td>
<td>In cases of recurrent dislocation LRR, VMO advancement or realignment</td>
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<tr>
<td>II</td>
<td>Patellar subluxation with no articular lesion</td>
<td>LRR and possible anteromedial tibial tubercle transfer (Fulkerson)*</td>
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<tr>
<td>A</td>
<td>Patellar tilt and subluxation with grade I, II chondromalacia</td>
<td>LRR, VMO advancement</td>
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<tr>
<td>B</td>
<td>Patellar tilt and subluxation with grade III, IV arthrosis</td>
<td>Lateral retinaculum release, VMO advancement</td>
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<tr>
<td>C</td>
<td>Patellar tilt and subluxation with grade III, IV arthrosis</td>
<td>LRR, debridement, and possible anteromedial tibial tubercle transfer*</td>
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<tr>
<td>III</td>
<td>Patellar tilt with no articular lesion</td>
<td>LRR</td>
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<tr>
<td>A</td>
<td>Patellar tilt with grade I, II chondromalacia</td>
<td>LRR</td>
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<tr>
<td>B</td>
<td>Patellar tilt with grade III, IV arthrosis</td>
<td>LRR, debridement, and possible anteromedial tibial tubercle transfer*</td>
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<tr>
<td>C</td>
<td>Patellar tilt with grade III, IV arthrosis</td>
<td>Nonoperative treatment, look for another source of pain</td>
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<tr>
<td>IV</td>
<td>No malalignment and no articular lesion</td>
<td>Consider arthroscopic debridement of grade II lesion</td>
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<tr>
<td>A</td>
<td>No malalignment and grade I, II chondromalacia</td>
<td>Arthroscopic debridement and possible tibial tubercle anterior advancement of 15mm in severe cases (Maquet procedure)*</td>
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<tr>
<td>B</td>
<td>No malalignment and grade I, II chondromalacia</td>
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<tr>
<td>C</td>
<td>No malalignment and grade III, IV arthrosis</td>
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LRR, lateral retinaculum release; VMO, vastus medialis obliquus advancement.

*LRR and VMO are indicated in patients younger than 40 years who had associated patellar tilt and subluxation but no arthrosis. In cases with associated patellar tilt, subluxation, and arthrosis, distal realignment vs patellectomy is indicated if patient is 40 to 60 years old and total knee arthroplasty, if older than 60 years.

Modified from Fulkerson and Hungerford. Reprinted with permission of Williams & Wilkins.

ence of subluxation, tilt, history of dislocation, and chondromalacia or osteoarthrosis (Table). Treatment recommendations have followed this classification.

Nonoperative treatment is preferable for patellofemoral pain. This includes a rehabilitation program with quadriceps straight-leg strengthening exercises with weights. Range of motion weight-resistant exercises should be avoided because they increase the forces on the patellofemoral joint. A patellar brace with a lateral buttress may be helpful. Conservative treatment also includes the use of nonsteroidal antiinflammatory drugs, physical modalities, and modification of daily activities.

More than 100 operations have been described for the treatment of patellofemoral disorders. They are directed at treating malalignment and other abnormalities of the extensor mechanism and patellofemoral joint or at treating the diseased cartilage.

Procedures for Malalignment.

The procedures that primarily address malalignment are divided into five categories: 1) release of the tightened lateral retinaculum, 2) proximal realignment of the extensor mechanism, 3) distal realignment of the extensor mechanism, 4) combined proximal and distal realignment of the extensor mechanism, and 5) patellectomy combined with realignment of the extensor mechanism.

Lateral Retinaculum Release. This procedure can be performed alone or in combination with other realignment procedures. Biomechanical studies have not shown any effect of this procedure on the patellofemoral contact area or pressure or on the PQ force ratio. The main surgical indications for this procedure are: 1) excessive lateral pressure syndrome with consistent tenderness and tightness in the lateral retinaculum, and patellar tilt or subluxation after failed conservative treatment, 2) painful patellofemoral arthrosis with lateral patellar tilt and minimal or no subluxation, and 3) persistent patellofemoral pain and lateral traction osteophyte at the insertion of the lateral retinaculum into the patella. It also is indicated, in combination with a realignment procedure of the patella, for chronic lateral subluxation or dislocation, but it is not recommended as an isolated realignment procedure. This procedure must be avoided in cases of patellofemoral pain syndrome of adolescence, advanced patellofemoral arthrosis, and normal patellar tracking. Surgical treatment of chondromalacia
of the patella has given unpredictable results in patients with normal axial radiographic findings.

The preoperative predictors of good results are pain reproduction, positive Gage's sign with palpation of the tight lateral retinaculum, negative or positive malalignment signs, and positive Merchant's view; the intraoperative predictor is the excess overhang of the patella, and the postoperative predictor is good reduction on Merchant's view. Incomplete release with insufficient postoperative passive patellar tilt in painful knees and more than five preoperative dislocations in knees with instability have been reported as unfavorable prognostic factors after arthroscopic lateral release.\(^{41}\) Pain relief after lateral retinaculum release probably is caused by a combination of patellar denervation and restoration of patellar congruence. Lateral retinaculum release reportedly is curative in most patients with chondromalacia patellae and excessive lateral pressure syndrome. The clinical results reported after lateral retinaculum release vary depending on the indications and the length of follow up; they have been reported to be satisfactory in 20% to 92% of patients.\(^{41-44}\) Because of the unpredictable results obtained with lateral retinaculum release, it has been recommended that the procedure should be performed in combination with vastus medialis obliquus advancement if malalignment is present.

The complications associated with lateral retinaculum release include hemarthrosis, medial subluxation of the patella, ankylosis, infection, and reflex sympathetic dystrophy.\(^{45}\) An overall complication rate of 7.2% was reported in one study.\(^{46}\) The incidence of hemarthrosis after arthroscopic lateral release varies from 2.2% to 10%.\(^{41,42}\)

Proximal Extensor Realignment Procedures. Several techniques of proximal (soft tissue) realignment have been described. A modification of the Insall technique is used most commonly (Fig 3).\(^{47}\) These procedures are indicated mainly for patients who\(^{48}\): 1) are skeletally immature and have a history of recurrent patellar dislocation; 2) are skeletally immature or mature, have persistent patellofemoral pain and an increased congruence angle, with or without significant patellar tilt and minimal or nonexistent arthrosis, and have no response to a vigorous, appropriate rehabilitation program; 3) have a dysplastic femoral trochlea and evidence of poor medial patellar support by the vastus medialis obliquus, which causes recurrent patellar subluxation or dislocation; and 4) have minimal or no arthrosis and require realignment of the patella without diminishing overall patellar contact stress.

Satisfactory clinical results have been obtained in 79% to 91% of patients after proximal realignment procedures.\(^{47-49}\) Positive prognostic indicators include young age, male gender, and postoperatively centralized patella.

Distal Realignment Procedures. These are the procedures used most commonly for recurrent patellar subluxation or dislocation. Many modifications of the transfer of the tibial tuberosity are used.

The main indications for these procedures include\(^{50}\): 1) persistent patellofemoral pain related to malalignment with excessive patellar tilt or increased congruence angle and need for relief of patellar contact stress because of patellar arthrosis (vastus medialis obliquus advancement may be added as needed to balance the patella in the trochlea); 2) lateral facet arthrosis and Q angle greater than 22°, with the patella centered in the trochlea; and 3) failed lateral release without evidence of lateral retinaculum reattachment and with significant residual lateral tilt. The chief contraindication is the presence of open growth plates of the proximal tibia in children for whom soft tissue distal realignment proce-

Fig 5: The technique of anteromedial tibial tubercle transfer and elevation (Fulkerson procedure). Use Steinmann pins as guides for the oblique osteotomy. The pins are inserted in an oblique angle close to the anterior tibial crest medially and directed postero-laterally, with the proximal pin penetrating the lateral tibial cortex about halfway between the anterior and posterior aspects of the lateral tibia (A). With a reciprocating saw, a cut is made obliquely from the proximal pin to a point just proximal to the lateral patellar tendon insertion, avoiding the metaphyseal region of the tibia (B). The distal bone pedicle is preserved, and the bony fragment is carefully immobilized and displaced medially, so that is slides anteriorly and medially. Two cancellous lag screws are used for fixation of the distal fragment, but the posterior tibial cortex must not be penetrated (C). (From Papageopoulos PJ, Sim FH, Morrey BF. Patelllectomy and reconstructive surgery for disorders of the patellofemoral joint. In: Morrey BF, ed. Reconstructive Surgery of the Joints. Ed 2. New York, NY: Churchill Livingstone; 1996; 2:1671-1699. Reprinted with permission of Mayo Foundation.)

The advantages of this procedure are realignment of the extensor mechanism, avoiding posterior placement of the tibial tubercle. The disadvantages are that it does not correct patella alta or infra and does not decrease patellofemoral compression force.

The main indications for the Roux-Elmslie-Trillat procedure are recurrent lateral patellar subluxation with an excessive Q angle and grade I or II patellar changes. Generally, distal realignment procedures with tibial tubercle transfer are contraindicated in cases with a normal Q angle or in children with an open epiphyseal plate due to growth arrest and genu recurvatum complications.

Satisfactory results have been reported in 80% to 96% of patients after the Roux-Elmslie-Trillat distal realignment procedure. Elevation of the Tibial Tubercle (Maquet Procedure). Maquet described the anterior advancement of the tibial tubercle with the use of a cortical cancellous bone graft for the alleviation of anterior knee pain. He recommended elevating the tibial tubercle 2 to 2.5 cm to achieve a 50% decrease in the patellofemoral compression force. However, a biomechanical study has recommended an elevation of 1.27 cm for an 83.5% decrease in patellofemoral force.

The main indications for the Maquet procedure include documented moderate-to-severe chondrosis or osteoarthritis unresponsive to conservative treatment and anterior knee pain associated with lateral subluxation of the patellar tendon after patelllectomy (Fig 4). The procedure also may be indicated for osteoarthritis in young athletes, particularly if the chondrosis is on the distal articular surface of the patella. The procedure is contraindicated for advanced, diffuse patellofemoral arthritis that involves the proximal patella.

Satisfactory clinical results of the Maquet procedure have been reported in 30% to 95% of patients. Predictors of successful outcome are...
skin slough, wound infection, fracture of the tibial tubercle, and stress fracture or displacement of the graft (5%).

We performed the Maquet procedure in 39 patients (mean age: 33 years): 27 with and 12 without a patella (Sim, unpublished data). Overall, 90% of the patients had a satisfactory result regardless of a prior patellectomy. However, wound complications developed in 58% of those with previous patellectomy.

Anteromedial Tibial Tubercle Transfer and Elevation (Fulkerson Procedure). Anteromedial tibial tubercle transfer and elevation has been advocated by Fulkerson54 (Fig 5). The procedure appears to be a reasonable modification for patients with malalignment, an increased Q angle, and arthrosis. Fulkerson et al65 reported 75% satisfactory results at a mean of 5 years postoperatively. Overall satisfactory results of 70% have been reported. The results have been satisfactory for all young patients without osteoarthritis and for 60% of patients with osteoarthritis or malalignment of the patella. Radin65 reported satisfactory results in 6 of 9 patients and 2 complications.

Procedures for the Articular Cartilage.

Commonly used procedures that primarily involve the articular surface include open or arthroscopic patellar shaving; local excision of defects, with drilling of the subchondral bone; facetectomy; mechanical decompression of the patellofemoral joint by elevating the tibial tuberosity anteriorly (Maquet procedure); patellectomy; patellar or patellofemoral replacement; and total knee replacement.

Arthroscopic Intervention. Arthroscopic shaving of the patella has become popular during the last decade. Few long-term results have been reported. The major benefit is probably from lavage of the joint and removal of debris from the articular surface.

Partial Chondrectomy and Subchondral Bone Drilling. Local excision of the defect and drilling of the subchon-
dral bone have been used commonly to treat severe advanced chondromalacia of the patella. The procedure allows blood vessels access to the surface defect, which, in turn, allows the production of a fibrocartilaginous covering. Good or excellent results have been achieved mostly in patients younger than 30 years.66

Patellectomy. The importance of the mechanics of the patella to the extensor mechanism has been emphasized.57 Clinical problems that frequently arise after patellectomy are diminished extension strength with extensor lag, thigh atrophy, decreased motion, residual pain, poor cosmesis, and, in some cases, increased tibiofemoral arthritis. Patellectomy decreases the efficiency of the quadriceps by as much as 30% and weakens it and increases the tension in the patellar tendon.67-69 The type of repair technique influences the results: a greater force is required for a longitudinal than for a transverse repair.58

Patellectomy should be considered as a last resort for treating a patellofemoral disorder. If a young patient has pronounced or posttraumatic patellofemoral arthritis, patellectomy is indicated. Another indication is severe patellofemoral pain after realignment procedures have failed in a patient younger than 40 years. The main contraindication is concurrent tibiofemoral disease or anterior patellofemoral pain of uncertain cause.

Different techniques of patellectomy have been reported, with satisfactory results reported in 75% of patients.70-73 There is no consensus about the indications for tubercle elevation or patellectomy in patients with patellofemoral pain. The Miyakawa patellectomy reportedly has subjective satisfactory results in 95% of the patients and objective satisfactory results in 90% at an average follow-up of 14 years.71

Patellectomy should be reserved for severe degenerative changes of the patella and should be considered a last resort. The best results have been achieved when patellectomy was performed for isolated patellofemoral disease. The extensor mechanism must be realigned after the operation (Fig. 6).

Patellofemoral Resurfacing. Patellar resurfacing was advocated in the 1950s for patellofemoral arthritis in patients with limited functional demands and poor quadriceps function.74 Patellofemoral arthroplasty was suggested as an alternative procedure.75 In young patients, patellofemoral implants have potential problems and restrictions. In older patients, these implants do not relieve the symptoms of tibiofemoral arthritis that are frequently present. Currently, neither patellar nor patellofemoral resurfacing is recommended.

Total Knee Arthroplasty. Total knee arthroplasty with patellar resurfacing is the best approach in elderly patients who primarily have patellofemoral disease. If this is performed without patellar resurfacing because of additional bone loss, lateral patellar tracking and residual quadriceps dysfunction often occur, and the result is less satisfactory.76

**CONCLUSION**

In conclusion, the medical history, clinical examination, and imaging assessment are important for accurately diagnosing patellofemoral disorders. Progress has been made recently in imaging the patellofemoral joint. CT and MRI are effective in assessing patellar maltracking under static and dynamic conditions. Stage III and IV cartilage changes are reliably evaluated with T2-weighted MRI scans. Arthroscopy is important in investigating the extent of patellar articular lesions and in confirming clinical and radiographic alignment. Effective treatment depends on an accurate diagnosis. Nonoperative treatment is indicated for any patient
who does not have patellar tilt, subluxation, or arthrosis. Operative procedures are directed to treating the mal-alignment of the extensor mechanism or diseased cartilage. The type of procedure selected depends on the age of the patient and the presence of patellar tilt, subluxation, and patellofemoral arthrosis.

REFERENCES


